ACS Webinars®
CLICK * WATCH * LEARN * DISCUSS

ACS Chemistry for Life®

We will start momentarily at 2pm ET

All recordings will be available to only ACS Members
http://acswebinars.org/drug-discovery

Have Questions?

ACS Chemistry for Life®

Type Questions Box!

"Why am I muted?"
Don't worry. Everyone is muted except the presenter and host. Thank you and enjoy the show.

Or tweet using #acswebinars

All recordings will be available to only ACS Members
http://acswebinars.org/drug-discovery

ACS Webinars®
CLICK • WATCH • LEARN • DISCUSS

ACS Chemistry for Life®

If you enjoy ACS Webinars® every Thursday… please support the program!

www.join.acs.org

ACS Network
Where Chemists Connect

ACS Network (search for group acswebinars)
www.communities.acs.org

Find the many benefits of ACS membership!

3

ACS Chemistry for Life®

www.facebook.com/acswebinars

4

How has ACS Webinars® benefited you?

"keeping me up to date with **new technologies**, giving me **tips to landing the perfect job**, and allowing me a weekly chance to feel like a chemist again even though I am unemployed!"

Fan of the Week

Elizabeth Thompson,
unemployed chemist

Be a featured fan on an upcoming webinar! Write to us @ acswebinars@acs.org

Travel Award to Summer 2014 London Science Forum

April 25, 2014; 3:00pm EDT

ACS International Center™
www.acs.org/ic

Richard O'Kennedy, Ph.D.
Biochemist
President, London International Youth Science Forum

www.acs.org/ic_london

The **London International Youth Science Forum (LIYSF)** is a two-week scientific conference with attendees from all over the world. Learn about this summer's upcoming forum, **July 23-August 6, 2014**, and how you can apply for a travel award to take you there.

Q: "Hungry for a brain snack?"

A: ACS WEBINETS™ on YouTube

"ACS Webinets™ are 2 minute segments that bring you valuable snippets from some of our most popular full length ACS Webinars® "

See all of our ACS Webinets™ on YouTube at http://bit.ly/acswebinets

7

ACS Webinars®
CLICK * WATCH * LEARN * DISCUSS

Beginning in 2014 all recordings of ACS Webinars will be available only to current ACS members.

We appreciate your patience while we work to complete the migration of past and current episodes, which we hope to have available as soon as possible.

Live weekly ACS Webinars will continue to be available to the general public.

Contact ACS Webinars ® at acswebinars@acs.org

8

Upcoming ACS Webinars®

www.acs.org/acswebinars.

Thursday, April 3, 2014

"Detecting Human Exposure to Environmental Toxins"

Elizabeth Hamelin, Centers for Disease Control and Prevention
Lucas Zarwell, Chief Toxicologist, District of Columbia

Thursday, April 10, 2014

"The Chemistry of Cocktails: Bruising and Louching and Fire Oh My!"

Darcy J. Gentleman, Ph.D, Science communicator, ACS Office of Public Affairs
Kathryn Verona, ACS Office of Public Affairs

Contact ACS Webinars ® at acswebinars@acs.org

9

Next in the 2014 Drug Discovery Series!

Session 3: Thursday, April 24, 2014

"Key Concepts in Identifying Drug Leads"

Chris Lipinski, Melior Discovery

Dr. Tudor Oprea, UNM School of Medicine, DTU Center for Biological Sequence Analysis

Contact ACS Webinars ® at acswebinars@acs.org

10

ACS Webinars®
CLICK • WATCH • LEARN • DISCUSS

ACS Chemistry for Life®

2014 Drug Discovery Series:
Session 2: Primer in Drug Target Classes

Slides Available Now! All recordings will be available to only ACS Members.

http://acswebinars.org/drug-discovery

Contact ACS Webinars ® at acswebinars@acs.org

Primer in Drug Target Classes

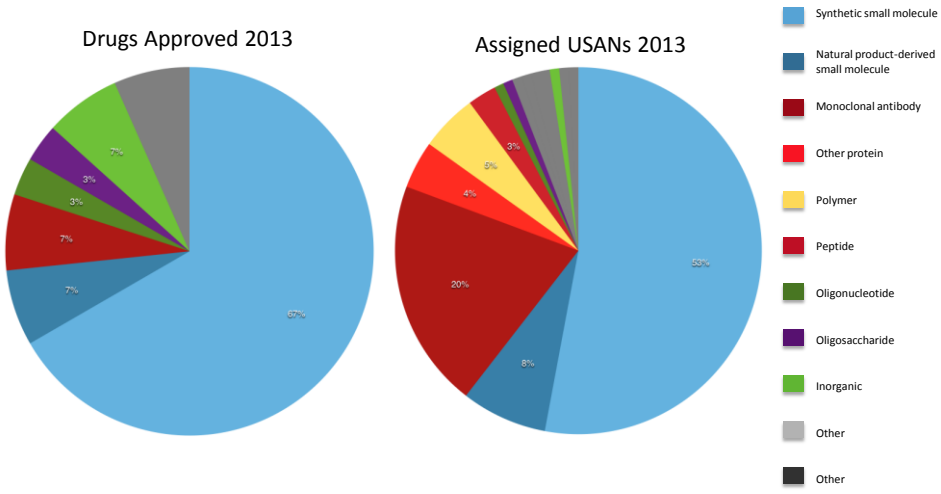
ACS webinars - 2014 Drug Discovery Series
Session 2: March 27th 2014

John P. Overington
EMBL-EBI

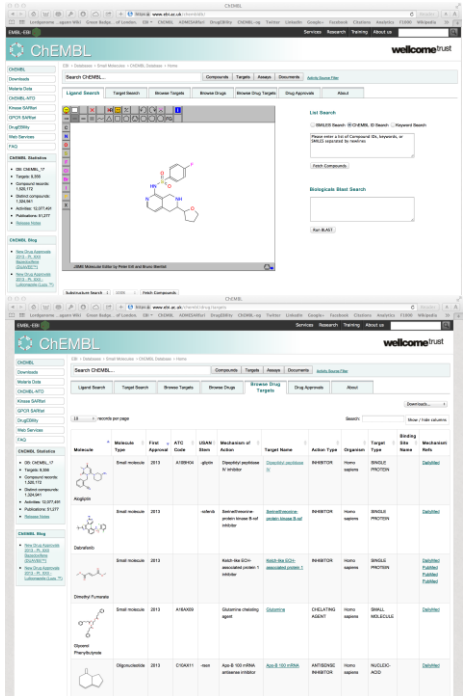
email: jpo@ebi.ac.uk
twitter: @johnpoverington
linkedin: uk.linkedin.com/in/joverington/

wellcome trust EMBL

Different Types of Drugs



Santos *et al*, *unpublished*



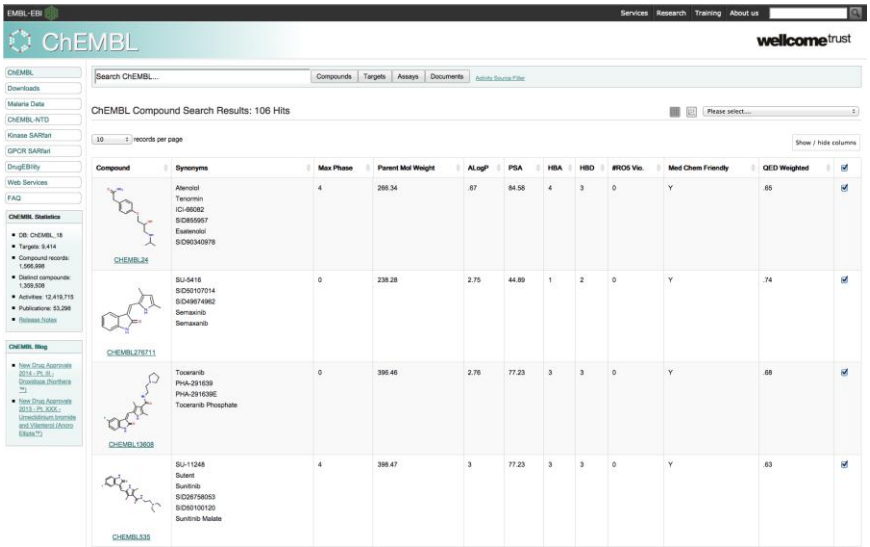
ChEMBL

https://www.ebi.ac.uk/chembl

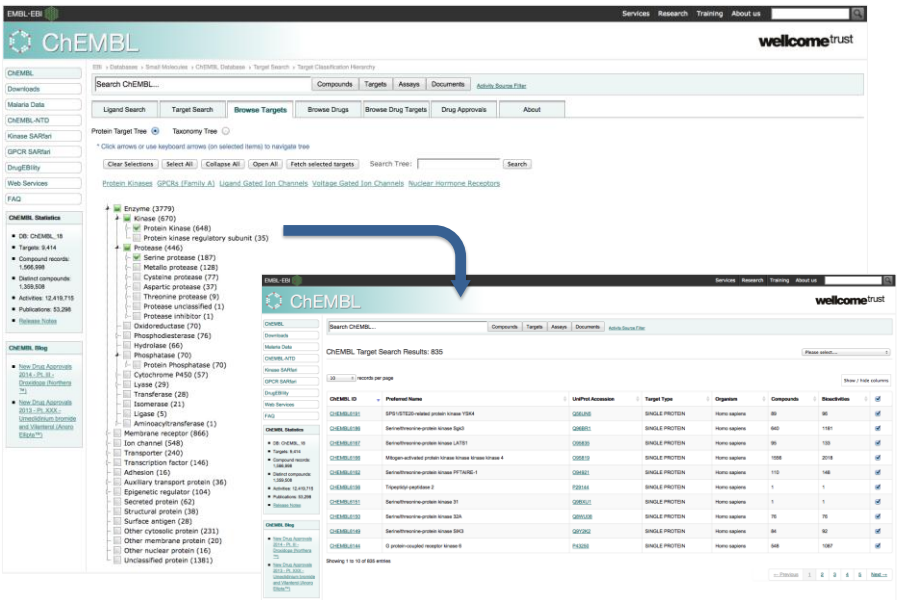
- The world's largest primary public database of medicinal chemistry data
  - ~1.4 million compounds, ~9,000 targets, ~12 million bioactivities
- Truly Open Data - CC-BY-SA license
- ChEMBL data also loaded into BindingDB, PubChem BioAssay and BARD

A. Gaulton et al (2012) *Nucleic Acids Research Database Issue.* **40** D1100-1107

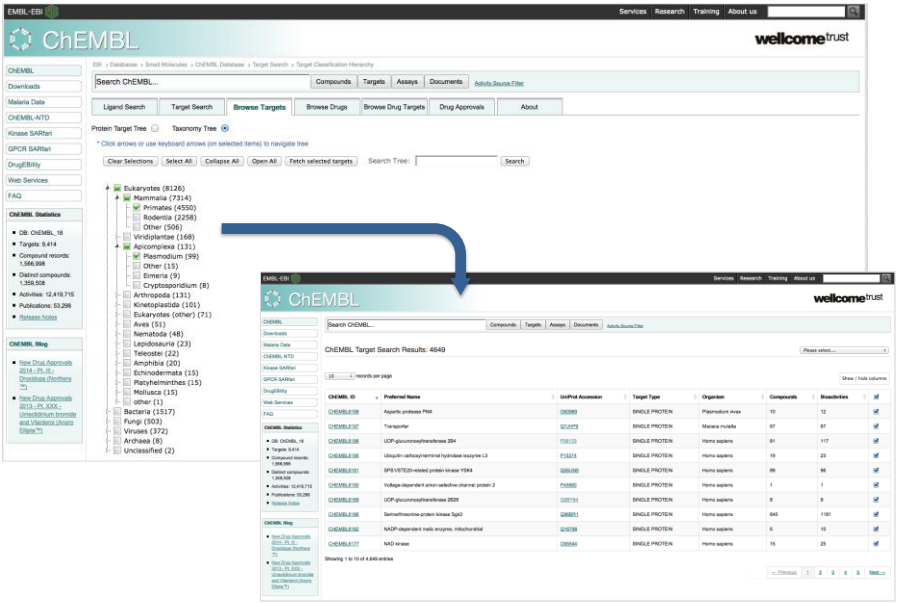
Spreadsheet Views



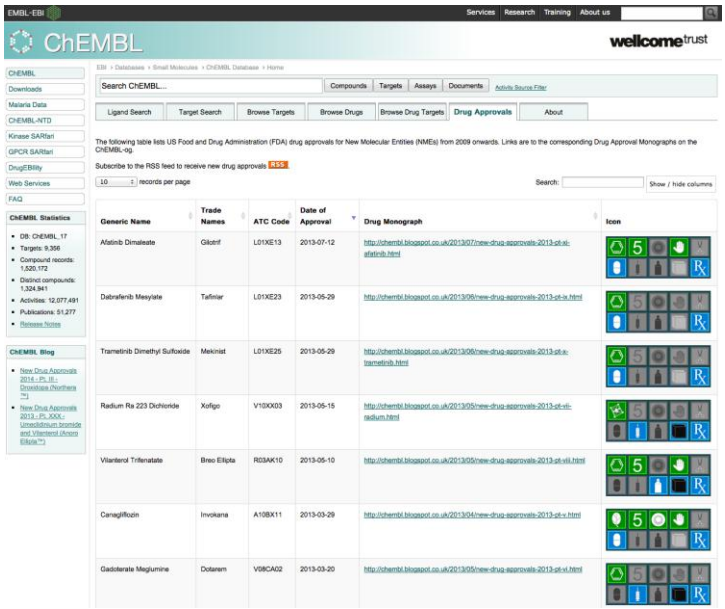
Target Class Data



Assay Organism Data

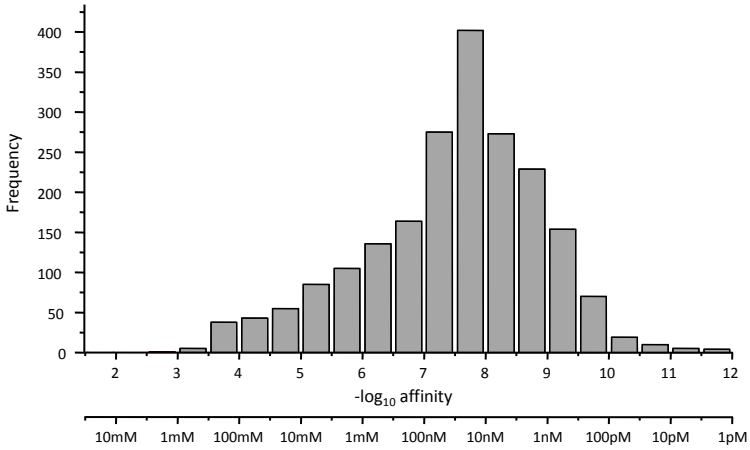


Drug Approvals

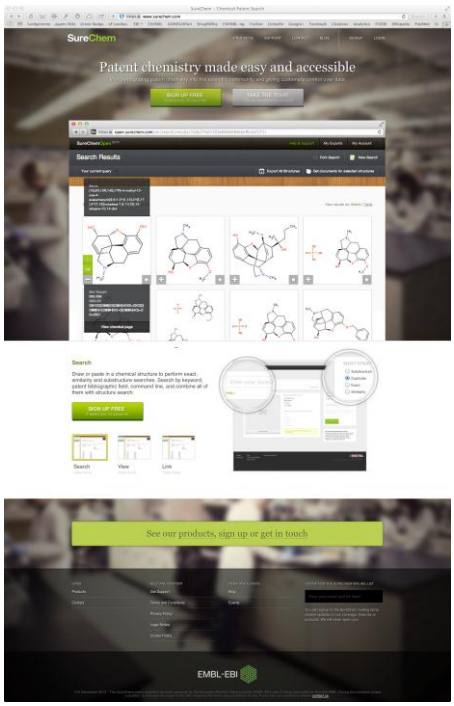


Affinity of Drugs for their 'Targets'

K_i, K_d, IC_{50}, EC_{50}, & pA_2 endpoints for drugs against their 'efficacy targets'



Overington, *et al, Nature Rev. Drug Disc.* **5** pp. 993-996 (2006) Gleeson *et al*, *Nature Rev. Drug Disc.* **10** pp. 197-208 (2011)



SureChEMBL

https://www.surechembl.org

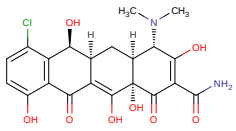
- New Public chemistry patent resource
- 'Acquired' SureChem product from Digital Science
  - Automatically extracted chemical structures from full-text patent
  - ~15 million chemical structures
  - Updated daily
  - Plan to add molecular target, sequence, disease, animal model, cell-line indexing….

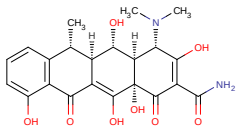
Antibacterial Drug Targets

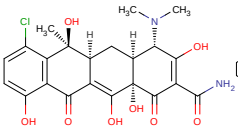
ATC Drug class	Target	Target type	Number of drugs
J01A Tetracyclines, J01G Aminoglycosides, J01XX Spectinomycin, J04AB Capreomycin	Ribosome 30S subunit	Riboprotein	24
J01B Amphenicols, J01F Macrolides, lincosamides, streptogramins, J01XX Linezolid	Ribosome 50S subunit	Riboprotein	22
J01XC Steroid antibiotics	Ribosome 70S ribosome-EF-G complex	Riboprotein	1
J01C Penicillins, J01D Cephalosporins, monobactams & carbapenems	Penicillin-binding proteins	Protein	85
J01C Bactams	Beta-lactamases	Protein	2
J01E Trimethoprims	DHFR	Protein	3
J01E Sulphonamides, J04AA Aminosalicylic acid, J04AB Dapsone, aldesulfone	Dihydropteroate synthase	Protein	23
J01M Quinolones	Topoisomerase II	Protein	27
J01XA Glycopeptides, J01XB Polymyxins, J01XD Imidazole derivatives, J01XE Nitrofuran derivatives, J01XX Xibornol, clofoctol, methenamine, mandelic acid, nitroxoline, daptomycin, bacitracin, J04AK Morinamide, delamanid, J04BA Clofazimine	-	-	22
J01XX Fosfomycin	UDP-N-acetylglucosamine enolpyruvyl transferase	Protein	1
J04AB Cycloserine, J04AK Terizidone	Alanine racemase + D-Ala-D-Ala ligase	Protein	2
J04AB Rifampicin derivatives	DNA-dependent RNA polymerase	Protein	4
J04AC Isoniazid, J04AD Thiocarbamide derivatives	Enoyl-acyl carrier protein reductase	Protein	4
J04AK Ethambutol	Arabinosyl transferase	Protein	1
J04AK Pyrazinamide	Fatty Acid Synthase I	Protein	1
J04AK Bedaquiline	ATP Synthase	Protein	1

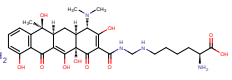
n.b. includes all antibacterial active ingredients with assigned ATC code

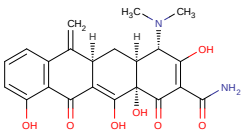
Approved Tetracycline Structures

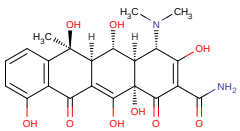

demeclocycline

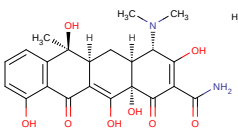

doxycycline

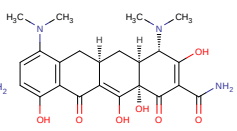

chlortetracycline

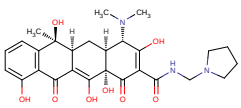

lymecycline

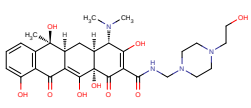

metacycline

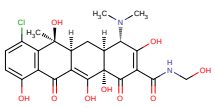

oxytetracycline

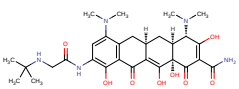

tetracycline


minocycline

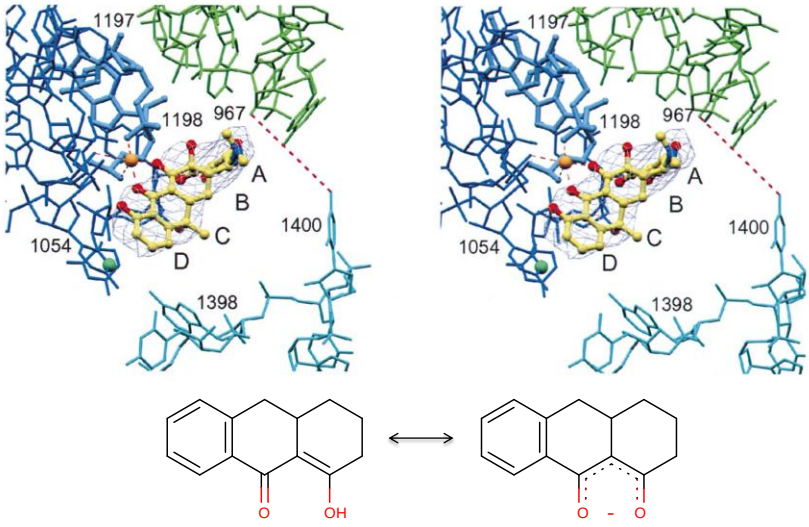

rolitetracycline


pipacycline


clomocycline


tigecycline

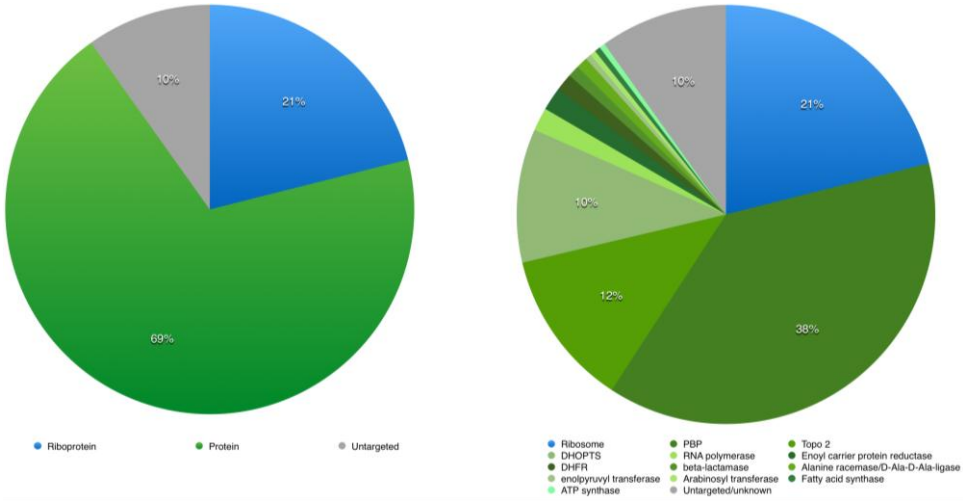
Tetracycline Binds 30S Ribosomal Subunit



Brodersen *et al. Cell*, **103** 1143–1154 (2000)

Antibacterial Drug Targets (J01 & J04)

N=223 drugs, 13 molecular targets – March 2014 ATC list

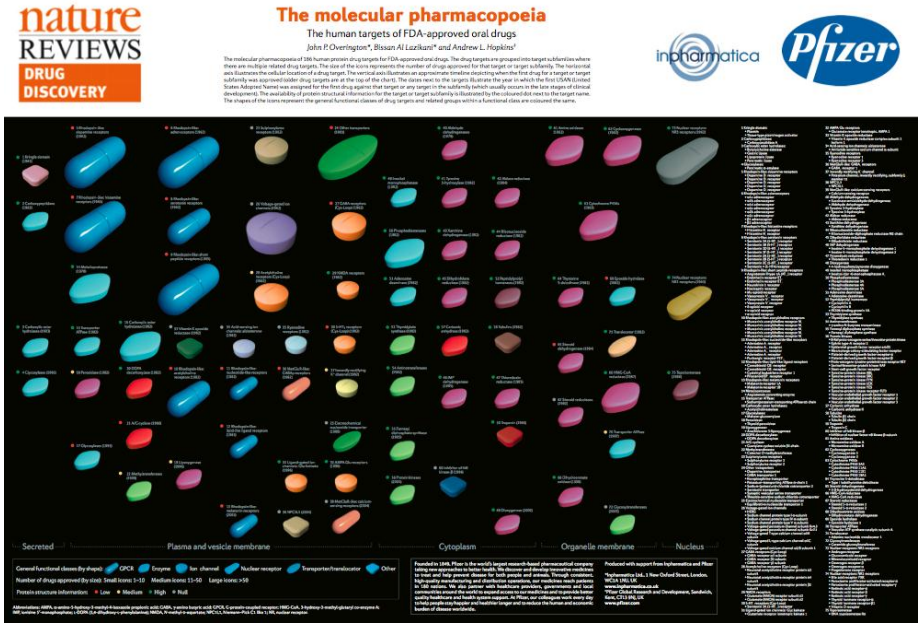


Santos & Overington *unpublished*

Audience Question

- What percentage of the human genome is a drug target?
- 53%
- 35%
- 8%
- 1%

Only ~1% of Genome is a Drug Target

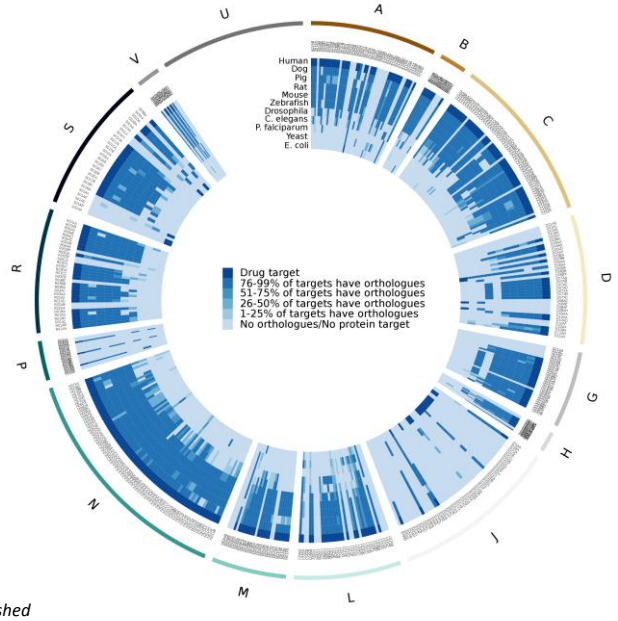


Drug Targets and Drugs

	Targets			Drugs		
Drug target Class	Total targets	Small-molecule drug targets	Biotherapeutic drug target	Total drugs	Small molecules	Biotherapeutics
Human Protein	315	243	86	1133	951	182
Pathogen Protein	52	49	4	205	200	5
Other human biomolecules	15	3	13	75	50	25
Other pathogen biomolecules	8	7	2	102	99	3

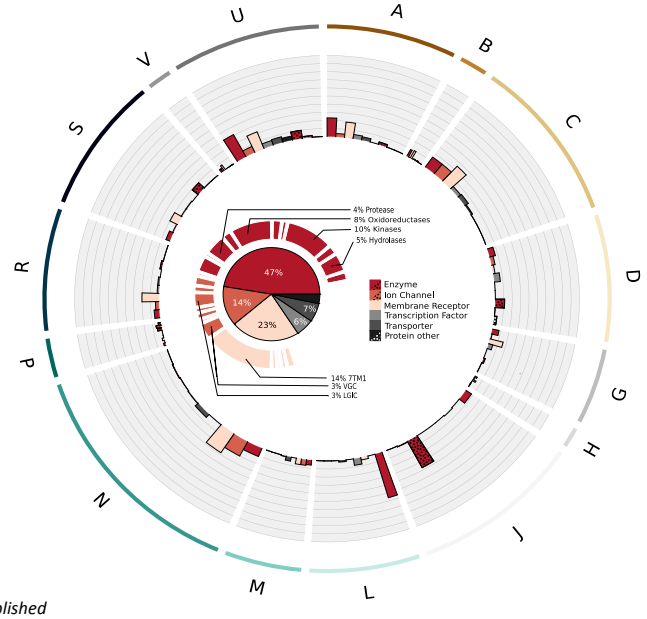
Santos *et al*, *unpublished*

Drug Targets Present in Model Organisms



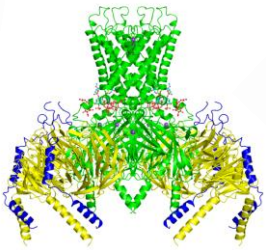
Santos *et al*, *unpublished*

Drug Target Classes and Therapeutic Areas



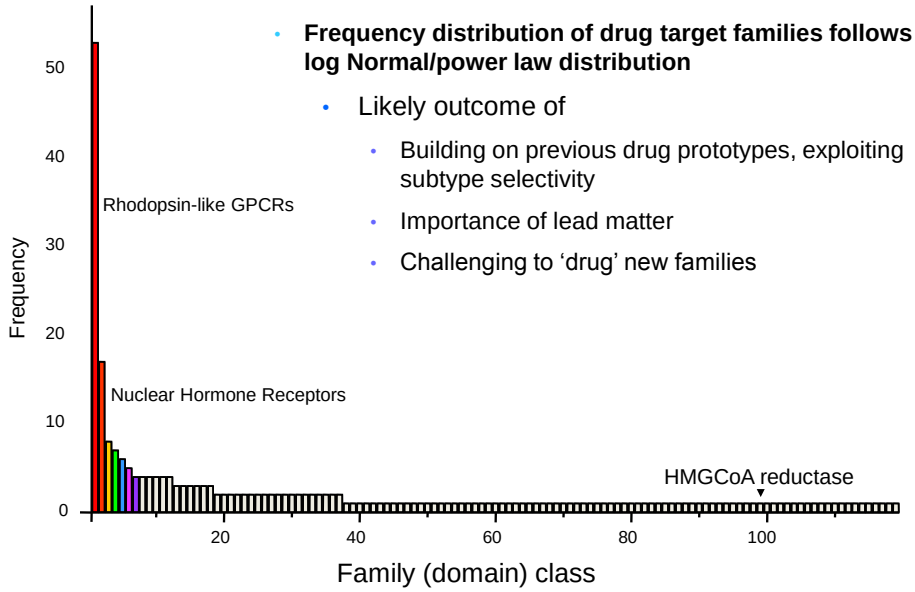
Santos *et al*, *unpublished*

Privileged Target Families

Rhodopsin-like GPCR PDBe: 3sn6	Ion channels PDBe: 4kfm	Nuclear receptors PDBe: 3e00	Protein kinases PDBe: 4foc
			
22% of drug targets 33% of small mol drugs	12% of drug targets 18% of small mol drugs	6% of drug targets 17% of small mol drugs	13% of drug targets 2.4% of small mol drugs

Over 53% of all targets and 70% of drugs modulate these four target classes

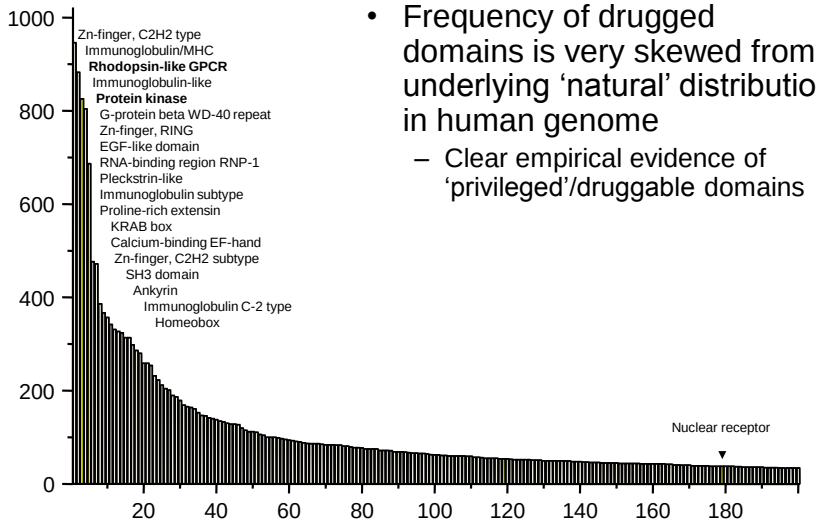
Molecular Targets of Current Drugs



- **Frequency distribution of drug target families follows a log Normal/power law distribution**
  - Likely outcome of
    - Building on previous drug prototypes, exploiting subtype selectivity
    - Importance of lead matter
    - Challenging to 'drug' new families

Overington, & Al-Lazikani *unpublished*

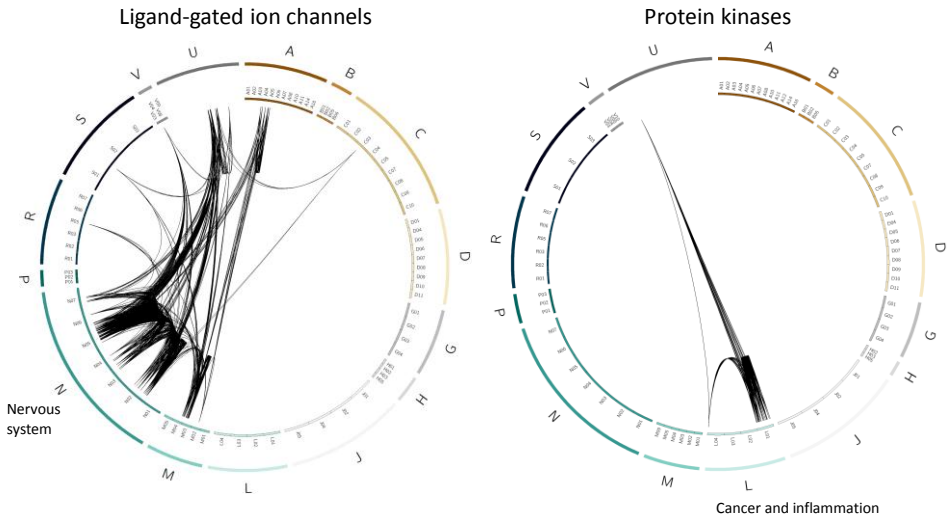
Domains within human genome



- Frequency of drugged domains is very skewed from underlying 'natural' distribution in human genome
  - Clear empirical evidence of 'privileged'/druggable domains

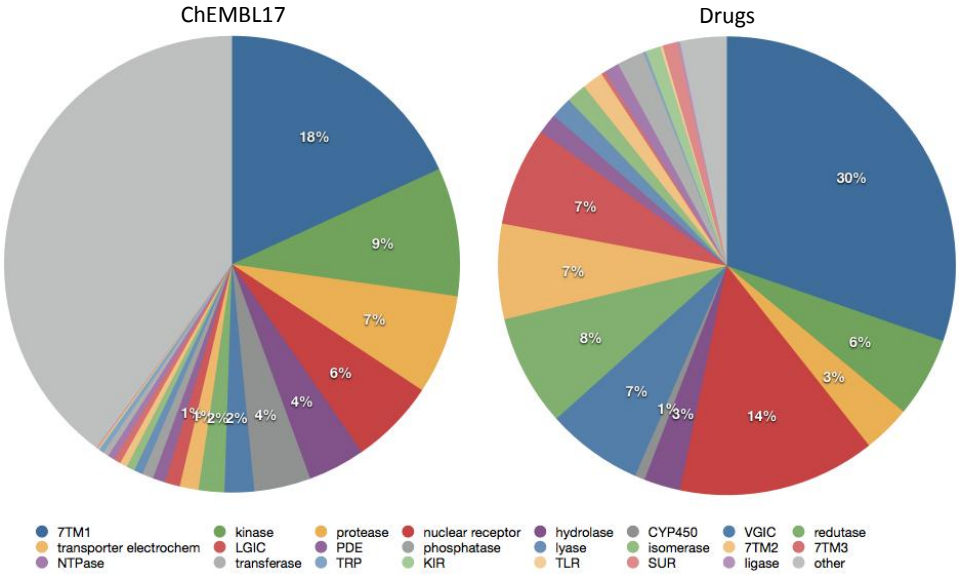
Overington, & Al-Lazikani *unpublished*

Footprint of Target Classes Across Disease



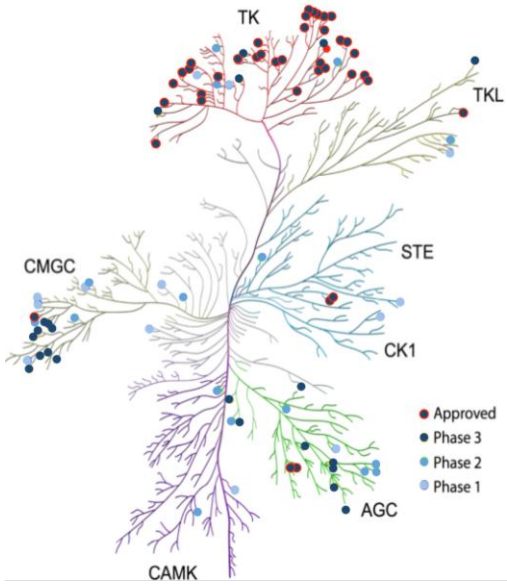
Santos *et al*, unpublished

Privileged Target Families



Santos, *unpublished*

Clinical Kinome



Overington, Al-Lazikani & Wennerberg, *unpublished*

Clinical Kinome

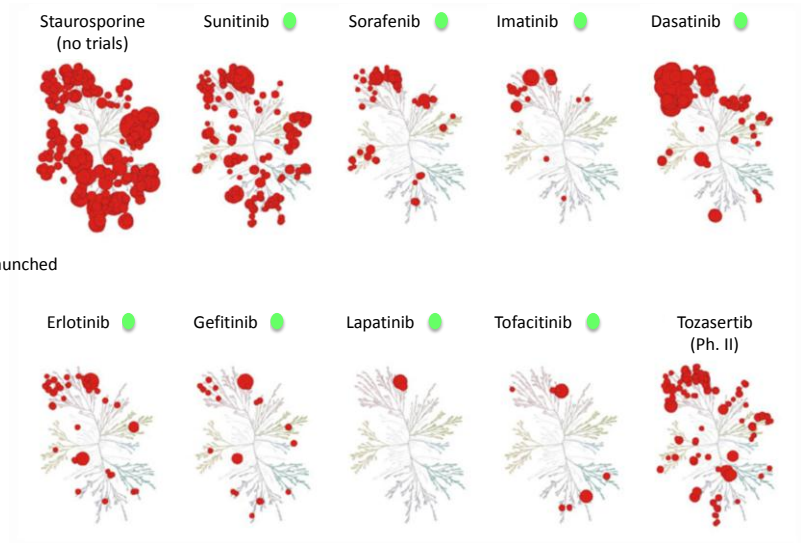
- 399 Clinical stage human kinase inhibitors
  - 29 Approved small molecule kinase inhibitors
    - 15 -tinib – tyrosine kinase inhibitors
    - *5 -rolimus – mTor inhibitors*
    - 4 -rafenib – Raf inhibitors
    - 2 -anib – angiogenesis inhibitors
    - 1 -metinib – met inhibitor
    - 1 brutinib – Bruton tyrosine kinase inhbitors
    - 1 -dil – Rho kinase inhibitor (Japan only)
  - 38 Phase 3
  - 143 Phase 2
  - 189 Phase 1
    - Phase 1:2 ratio is atypical due to many kinase inhibitor trials being phase 1/2 oncology trials

Kinase Inhibitors in Clinical Development

Research Code	Research Code Alternate 1	Research Code Alternate 2	Research Code Alternate 3	Research Code Alternate 4	Research Code Alternate 5	USAN/INN	USAN stem	INN Year	Tradename US	Tradename EUR	Tradename JAP	ATC	Vet ATCC	High Phase	Company	Class	Target Class
AG-13736						Axitinib	-tinib	2005	Inlyta	Inlyta		L01XE17	QL01XE17	4	Pfizer	TK	multi
AMN-107	NVP-AMN107					Nilotinib	-tinib	2006	Tasigna	Tasigna		L01XE08	QL01XE08	4	Novartis		multi
AP-24534						Ponatinib	-tinib	2010	Iclusig	Iclusig		L01XE24		4	Ariad		multi
AZD-1839	ZD-1839					Gefitinib	-tinib	2002	Iressa	Iressa		L01XE02	QL01XE02	4	AstraZeneca	TK	EGFR
BIBW-2992						Afatinib	-tinib	2013	Gilotrif	Tovok	Tomtovok	L01XE13	QL01XE13	4	Boehringer Ingelheim	TK	EGFR
BMS-354825						Dasatinib	-tinib	2006	Sprycel	Sprycel		L01XE06	QL01XE06	4	Bristol-Myers Squib		multi
BMS-907351	XL-184					Cabozantinib	-tinib	2011	Cometriq			L01XE		4	Bristol-Myers Squib		multi
CP-690550					Tasocitinib	Tofacitinib	-tinib	2013	Xeljanz			L04AA29		4	Pfizer	TK	JAK
GW-572016	GW-2016					Lapatinib	-tinib	2003	Tykerb	Tyverb		L01XE07	QL01XE07	4	GlaxoSmithKline	TK	EGFR
INCB-18424	INC-424					Ruxolitinib	-tinib	2010	Jakafi	Jakavi		L01XE18	QL01XE18	4	Incyte	TK	JAK
OSI-774	CP-358774	R-1415	NSC-718781	RG-1415	Rs-508231	Erlotinib	-tinib	2001	Tarceva			L01XE03	QL01XE03	4	Astellas	TK	EGFR
PF-02341066						Crizotinib	-tinib	2009	Xalkori			L01XE16	QL01XE16	4	Pfizer		ALK MET RON
PF-05208763	SKI-606					Bosutinib	-tinib	2005	Bosulif			L01XE14	QL01XE14	4	Pfizer		ABL1 SRC
STI-571	NVP-BTS71	CGP-57148				Imatinib	-tinib	2002	Glivec	Gleevec		L01XE01	QL01XE01	4	Novartis		ABL1 DDR1 KIT (PDGFR)
SU-11248						Sunitinib	-tinib	2006	Sutent	Sutent		L01XE04	QL01XE04	4	Pfizer	TK	multi
ABT-578						Zotarolimus	-rolimus	2005	Endeavor Resolute					4	Abbott		MTOR
AY-22989					Rapamycin	Sirolimus	-rolimus	1999	Rapamune Cypher	Rapamune Cypher	Cypher	L04AA10	QL01AA10	4	Pfizer		MTOR
CCI-779						Temsirolimus	-rolimus	2004	Torisel	Torisel		L01XE09	QL01XE09	4	Pfizer		MTOR
FK-506					Fujimycin	Tacrolimus	-rolimus	1992	Prograf	Advagraf Modigraf Protopic Protopy	Prograf Graceptor	L04AD02 D11AH01	QD11AH01 QL04AD02	4	Astellas		FKBP-12/Calcineurin Calcineurin
RAD-001	NVP-RAD001					Everolimus	-rolimus	2003	Zortress Zortican Afinitor Xience V	Afinitor Votubia Certican		L01XE10 L04AA18	QL01XE10 QL04AA18	4	Novartis		FKBP-12/MTOR MTOR
WAY-ASM-981						Pimecrolimus	-rolimus	2000	Elidel			D11AH02	QL01AH02	4	Galderma		FKBP-12/Calcineurin Calcineurin
WYE-125	Ba-9	A-9			Biolimus A9	Umirolimus	-rolimus	2009			Nobori			4	Biosensors International		FKBP-12/MTOR MTOR
BAY-43-9006						Sorafenib	-rafenib	2007	Nexavar	Nexavar		L01XE05	QL01XE05	4	Bayer Health Care	TK	KIT (PDGFR) RAF1 VEGFR2 VEGFR3 multi
BAY-73-4506						Regorafenib	-rafenib	2008	Stivarga			L01XE21		4	Bayer Health Care	TK	ABL BRAF DDR2 EPH2A (FGFR) KIT (PDGFR) PTK5 RAF1 RET SAPK2 TRK2A (VEGFR) TIE2 multi
GSK-2118436						Dabrafenib	-rafenib	2011	Tafinlar			L01XE23		4	GlaxoSmithKline		BRAF RAF
RG-7204	PLX-4032	Rs-5185426				Vemurafenib	-rafenib	2010	Zelboraf	Zeboraf		L01XE15	QL01XE15	4	Roche		BRAF MEK1 MEK2 RAF1 RAF
GSK-1120212	JTP-74057					Trametinib	-metinib	2011	Mekinist			L01XE25		4	GlaxoSmithKline		MEK1 MEK2 MEK
Y-27632	AT-877	HA-1077				Fasudil	-sil	1997			Eril	C04AX32		4	Asahi Kasei Pharma		ROCK
AZD-6474	ZD-6474					Vandetanib	-anib	2006	Zactima	Caprelsa		L01XE12	QL01XE12	4	AstraZeneca	TK	EGFR (EPHR) ERBB2 RET TIE2 BRK (VEGFR) multi
GW-786034						Pazopanib	-anib	2005	Votrient	Votrient		L01XE11	QL01XE11	4	GlaxoSmithKline	TK	KIT (PDGFR) (VEGFR) multi
AB-1010						Masitinib	-tinib	2007	Masivet			L01XE22	QL01XE90	3	AB Science	TK	FGFR3 KIT multi
ARQ-197						Tivantinib	-tinib	2010						3	Arqule		MET
AZD-0530	AZ-10353926					Saracatinib	-tinib	2009						3	AstraZeneca		ABL1 SRC multi
BPI-2009H						Icotinib	-tinib							3	Beta Pharma		EGFR
CEP-701	KT-555	SP-924	SPM-924	A-154475		Lestaurtinib	-tinib	2004						3	Teva	TK	FLT3 JAK2 NTRK1 (PKC) RET multi
CI-1033	PD-183805	SN-26606				Canertinib	-tinib	2002						3	Pfizer	TK	EGFR ERBB2 EGFR
E-7080	ER-203492					Lenvatinib	-tinib	2010						3	Eisai	TK	(VEGFR) VEGFR
HKI-272	WAY-179272	CDP-820				Neratinib	-tinib	2006						3	Pfizer	TK	EGFR ERBB2 EGFR
IY-5511						Radotinib	-tinib	2011						3	Ilyang Pharm	TK	ABL ABL

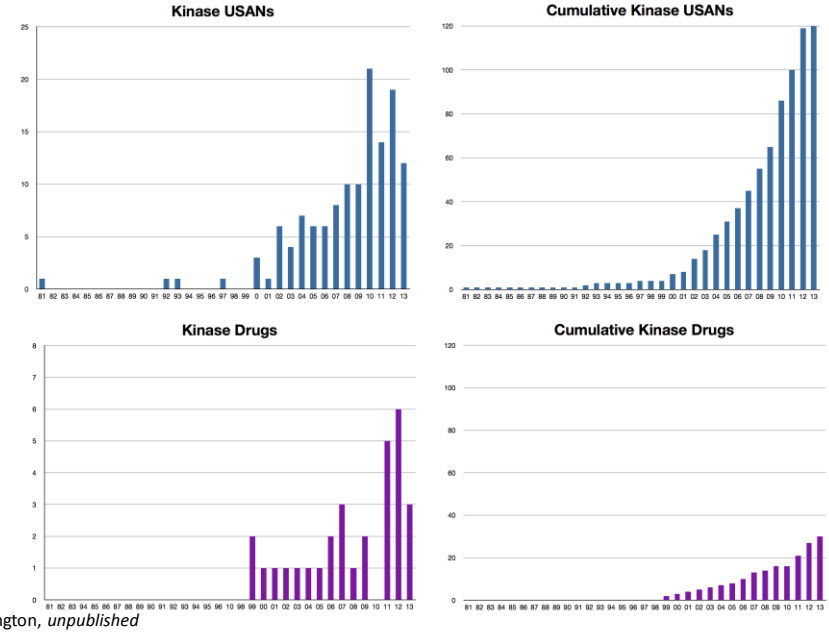
Overington, Bellis, Al-Lazikani & Wennerberg, *unpublished*

Kinase Inhibitor Polypharmacology



Adapted from Ghoreschi *et al*, *Nature Immunology* **10**, 356 - 360 (2009)

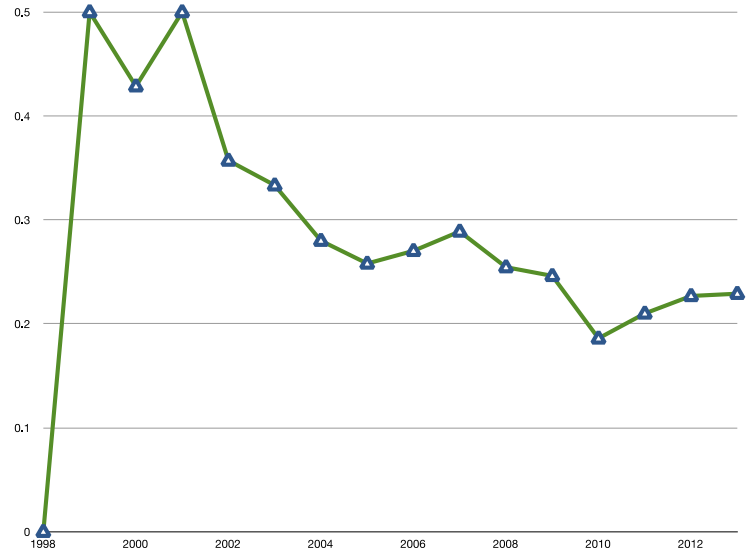
Kinase Inhibitor Attrition



Overington, *unpublished*

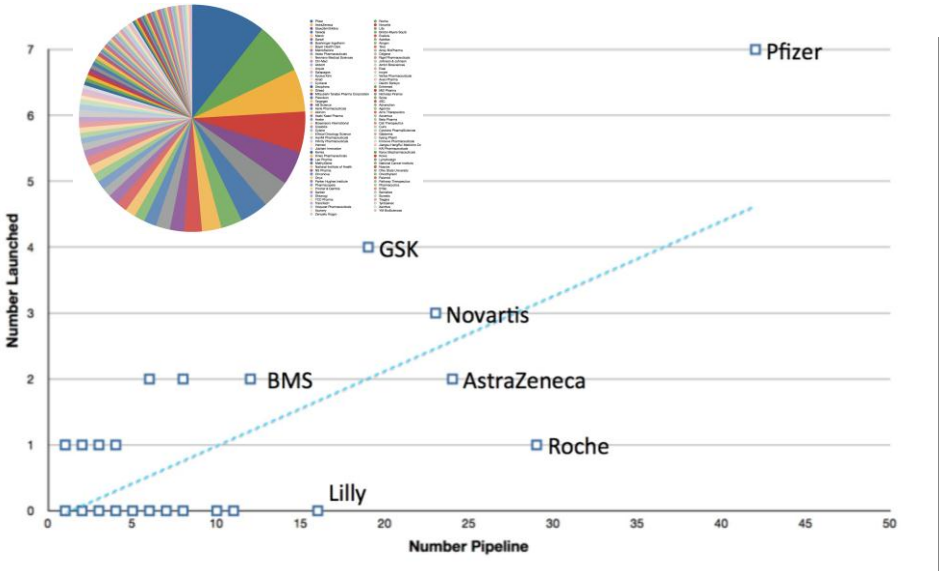
Kinase Inhibitor Attrition

USAN to approved fraction! – ~0.2 is long term mean for all drugs across all classes



Overington, *unpublished*

Kinase Inhibitor Productivity



Overington, *unpublished*

Cancer Drugs and Targets

Overington, Al-Lazikani, Hopkins, *Nat Rev Drug Discov*. **6** 2006 5:993-6 (2008)
Updated in canSAR: Bulusu *et al, Nucleic Acids Res.* **42** D1040-7 (2014)

Cancer Genes

Science 29 March 2013:
Vol. 339 no. 6127 pp. 1546–1558
DOI: 10.1126/science.1235122

REVIEW

Cancer Genome Landscapes

Bert Vogelstein, Nickolas Papadopoulos, Victor E. Velculescu, Shibin Zhou, Luis A. Diaz Jr., Kenneth W. Kinzler*

Nature **502**, 333–339 (17 October 2013) | doi:10.1038/nature12634

Mutational landscape and significance across 12 major cancer types

Cyriac Kandoth, Michael D. McLellan, Fabio Vandin, Kai Ye, Beifang Niu, Charles Lu, Mingchao Xie, Qunyuan Zhang, Joshua F. McMichael, Matthew A. Wyczalkowski, Mark D. M. Leiserson, Christopher A. Miller, John S. Welch, Matthew J. Walter, Michael C. Wendl, Timothy J. Ley, Richard K. Wilson, Benjamin J. Raphael & Li Ding

Affiliations | Contributions | Corresponding author

Nature **502**, 333–339 (17 October 2013) | doi:10.1038/nature12634

Review

Nature Reviews Cancer **4**, 177-183 (March 2004) | doi:10.1038/nrc1299

A census of human cancer genes

P. Andrew Futreal, Lachlan Coin, Mhairi Marshall, Thomas Down, Timothy Hubbard, Richard Wooster, Nazneen Rahman & Michael R. Stratton

Discovery and saturation analysis of cancer genes across 21 tumour types

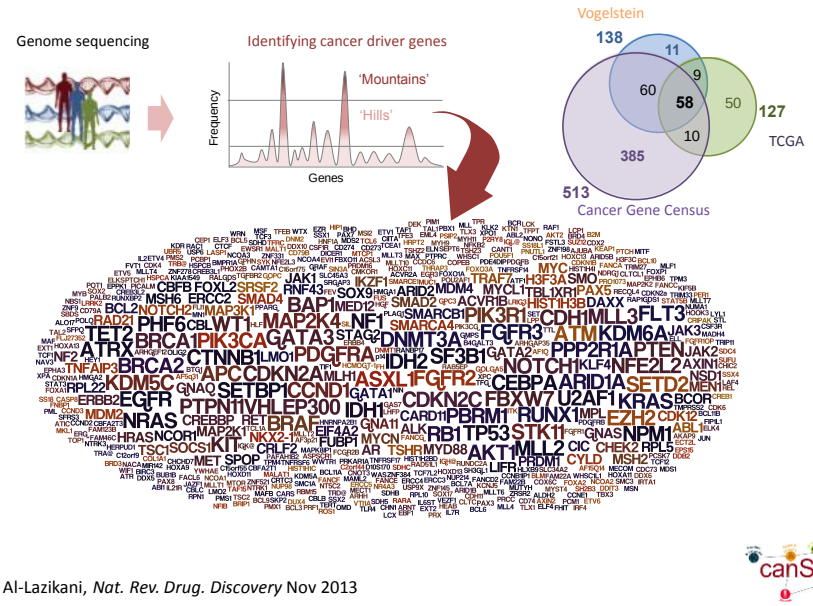
Michael S. Lawrence, Petar Stojanov, Craig H. Mermel, James T. Robinson, Levi A. Garraway, Todd R. Golub, Matthew Meyerson, Stacey B. Gabriel, Eric S. Lander & Gad Getz

Affiliations | Contributions | Corresponding authors

Nature **505**, 495–501 (23 January 2014) | doi:10.1038/nature12912

canSAR

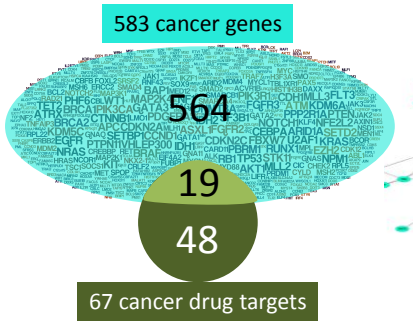
Cancer Genomics and Targets

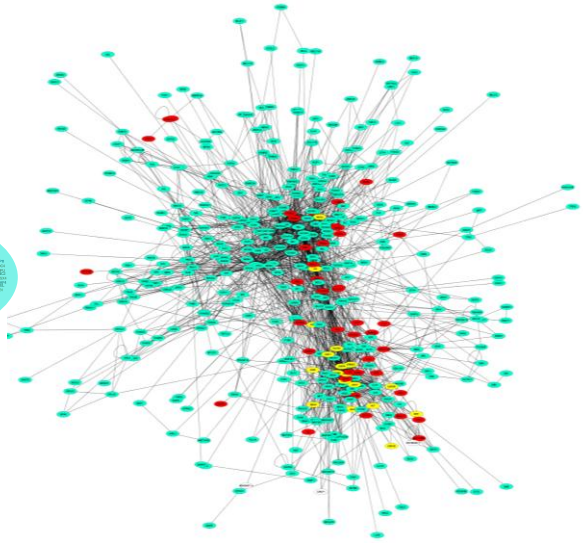


canSAR

Workman & Al-Lazikani, *Nat. Rev. Drug. Discovery* Nov 2013

Cancer Targets



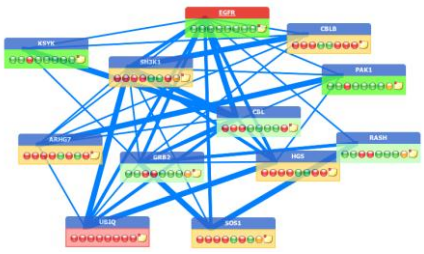


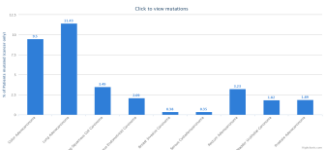
Al-Lazikani *et al, unpublished*

Genomic Data Integration

http://cansar.icr.ac.uk

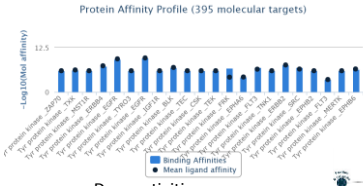
Drug annotated target networks





Mutation profiles

Network environment profiles



Drug activities

Bulusu *et al, Nucleic Acids Res*. **42** Jan;42:D1040-7 (2014)

Audience Question

What will the future of drug targets be focused on?

- GPCRs
- Nuclear Receptors
- Ion Channels
- Enzymes
- Non-Enzymes

Centre for Therapeutic Target Validation

- Collaboration to pinpoint processes in the human body that impact on disease.
- Public-private initiative:
  - GSK: expertise in disease biology and translational medicine
  - EMBL-EBI: expertise in life science data integration and analysis
  - Wellcome Trust Sanger Institute: expertise in the role of genetics in disease

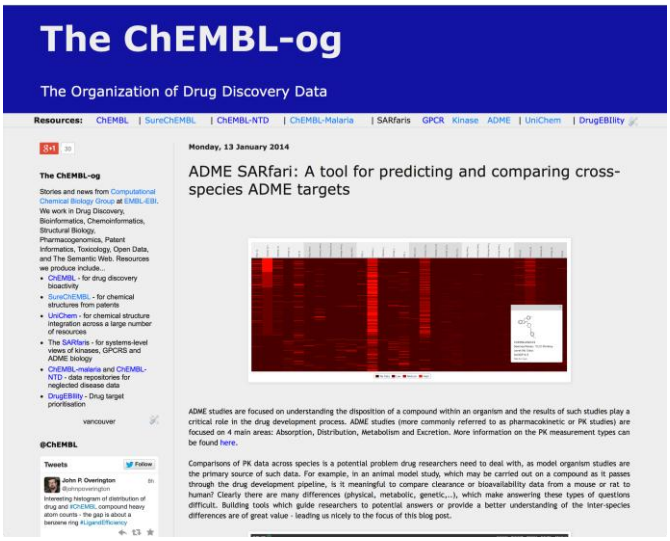
Acknowledgements

ChEMBL Database
Anne Hersey
Anna Gaulton
Mark Davies
Michal Nowotka
George Papadatos
Jon Chambers
Louisa Bellis
Rita Santos
Gerard Van Westen
Ruth Akhtar
Francis Atkinson
Patricia Bento
Ramesh Donadi
John Paul Overington

Institute of Cancer Research
Bissan Al-Lazikani
Paul Workman

FIMM, Helsinki
Krister Wennerberg

University of Dundee
Andrew Hopkins

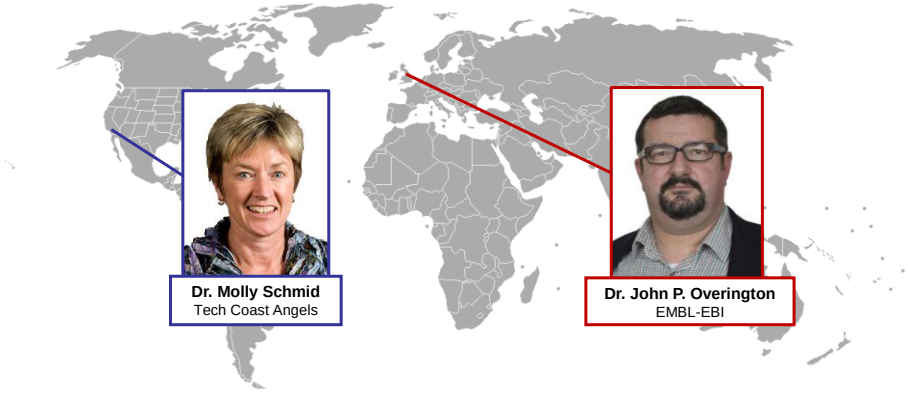


http://chembl.blogspot.com

ACS Webinars®
CLICK * WATCH * LEARN * DISCUSS

ACS Chemistry for Life®

2014 Drug Discovery Series:
Session 2: Primer in Drug Target Classes



Dr. Molly Schmid
Tech Coast Angels

Dr. John P. Overington
EMBL-EBI

Slides Available Now! All recordings will be available to only ACS Members.

http://acswebinars.org/drug-discovery

Contact ACS Webinars ® at acswebinars@acs.org

Next in the 2014 Drug Discovery Series!

Session 3: Thursday, April 24, 2014

"Key Concepts in Identifying Drug Leads"

Chris Lipinski, Melior Discovery

Dr. Tudor Oprea, UNM School of Medicine, DTU Center for Biological Sequence Analysis

Upcoming ACS Webinars®

www.acs.org/acswebinars.

Thursday, April 3, 2014

"Detecting Human Exposure to Environmental Toxins"

Elizabeth Hamelin, Centers for Disease Control and Prevention
Lucas Zarwell, Chief Toxicologist, District of Columbia

Thursday, April 10, 2014

"The Chemistry of Cocktails: Bruising and Louching and Fire Oh My!"

Darcy J. Gentleman, Ph.D, Science communicator, ACS Office of Public Affairs
Kathryn Verona, ACS Office of Public Affairs

ACS Webinars®
CLICK • WATCH • LEARN • DISCUSS

ACS Chemistry for Life®

2014 Drug Discovery Series:
Session 2: Primer in Drug Target Classes

Slides Available Now! All recordings will be available to only ACS Members.

http://acswebinars.org/drug-discovery

Contact ACS Webinars ® at acswebinars@acs.org

How has ACS Webinars® benefited you?

ACS Chemistry for Life®

"keeping me up to date with **new technologies**, giving me **tips to landing the perfect job**, and allowing me a weekly chance to feel like a chemist again even though I am unemployed!"

Fan of the Week

Elizabeth Thompson,
unemployed chemist

Be a featured fan on an upcoming webinar! Write to us @ **acswebinars@acs.org**

54

ACS Webinars®
CLICK • WATCH • LEARN • DISCUSS

ACS Chemistry for Life®

Stay Connected…

facebook www.facebook.com/acswebinars

www.twitter.com/acswebinars

LinkedIn (search group for acswebinars)

Email ACS Webinars ® at acswebinars@acs.org

55

ACS Webinars®
CLICK • WATCH • LEARN • DISCUSS

ACS Chemistry for Life®

If you enjoy ACS Webinars® every Thursday… please support the program!

www.join.acs.org

ACS Network
Where Chemists Connect

ACS Network (search for group acswebinars)
www.communities.acs.org

Find the many benefits of ACS membership!

56

ACS Webinars®
CLICK * WATCH * LEARN * DISCUSS

ACS Chemistry for Life®

ACS Webinars® does not endorse any products or services. The views expressed in this presentation are those of the presenter and do not necessarily reflect the views or policies of the American Chemical Society.

Upcoming ACS Webinars®

www.acs.org/acswebinars.

ACS Chemistry for Life®

Thursday, April 3, 2014

"Detecting Human Exposure to Environmental Toxins"

Elizabeth Hamelin, Centers for Disease Control and Prevention
Lucas Zarwell, Chief Toxicologist, District of Columbia

Thursday, April 10, 2014

"The Chemistry of Cocktails: Bruising and Louching and Fire Oh My!"

Darcy J. Gentleman, Ph.D, Science communicator, ACS Office of Public Affairs
Kathryn Verona, ACS Office of Public Affairs